

# **New Hampshire Variable Milfoil Research Activities**

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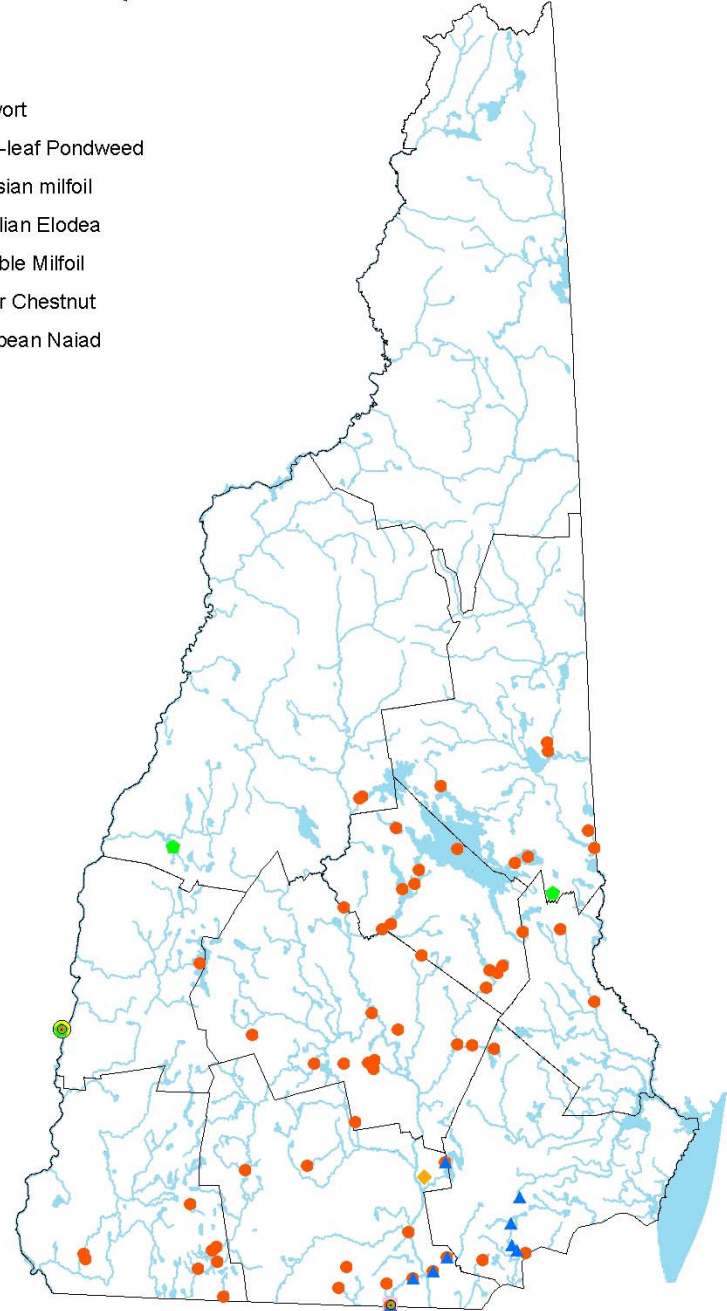


**54**  
**variable milfoil**  
**infestations**

## EXOTIC AQUATIC PLANT SITES IN NEW HAMPSHIRE

### SPECIES

- ▲ Fanwort
- Curly-leaf Pondweed
- Eurasian milfoil
- ◆ Brazilian Elodea
- Variable Milfoil
- Water Chestnut
- European Naiad





# Variable Milfoil Related Research: More information needed on this plant!

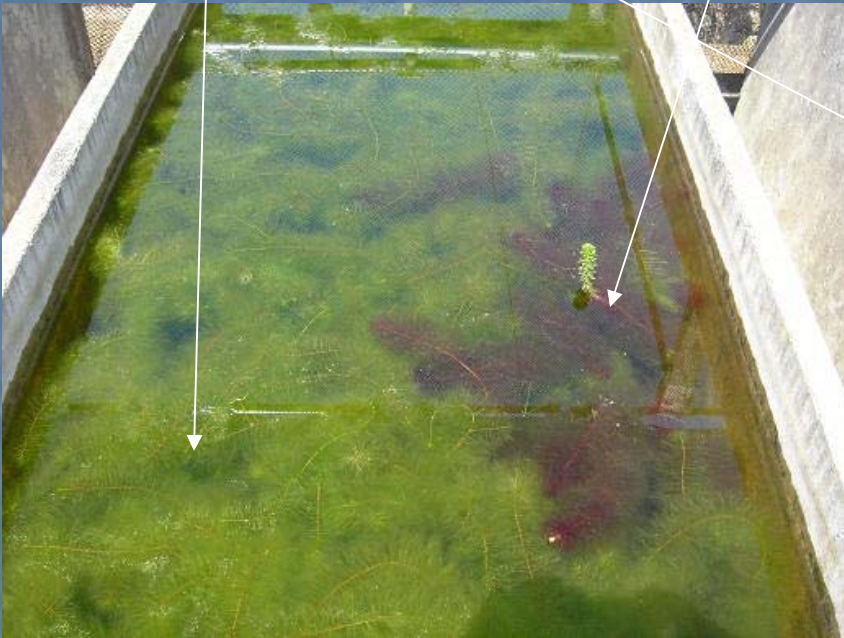
- Why are only a few New England states so impacted with variable milfoil?
- Are there longer term control measures out there?
- Can a risk assessment be developed to help predict the spread of milfoil?





Northern VM

Southern VM



# Timeframe

- Federal money came to NH in fall 2004
- Projects started in winter 2005
- 1-2 year research timeframes (project specific)
  - Summer 2005 field research began
- Data and reports in Fall/Winter 2006







# Six projects can be broken down into two categories:

- Tools for Risk Assessment
  - Lake and sediment characteristics
  - Statistics
  - Lake morphology/geology of basin
- Tools for Management
  - Biological control
  - Chemical control
  - Physical control

# Tools for Risk Assessment



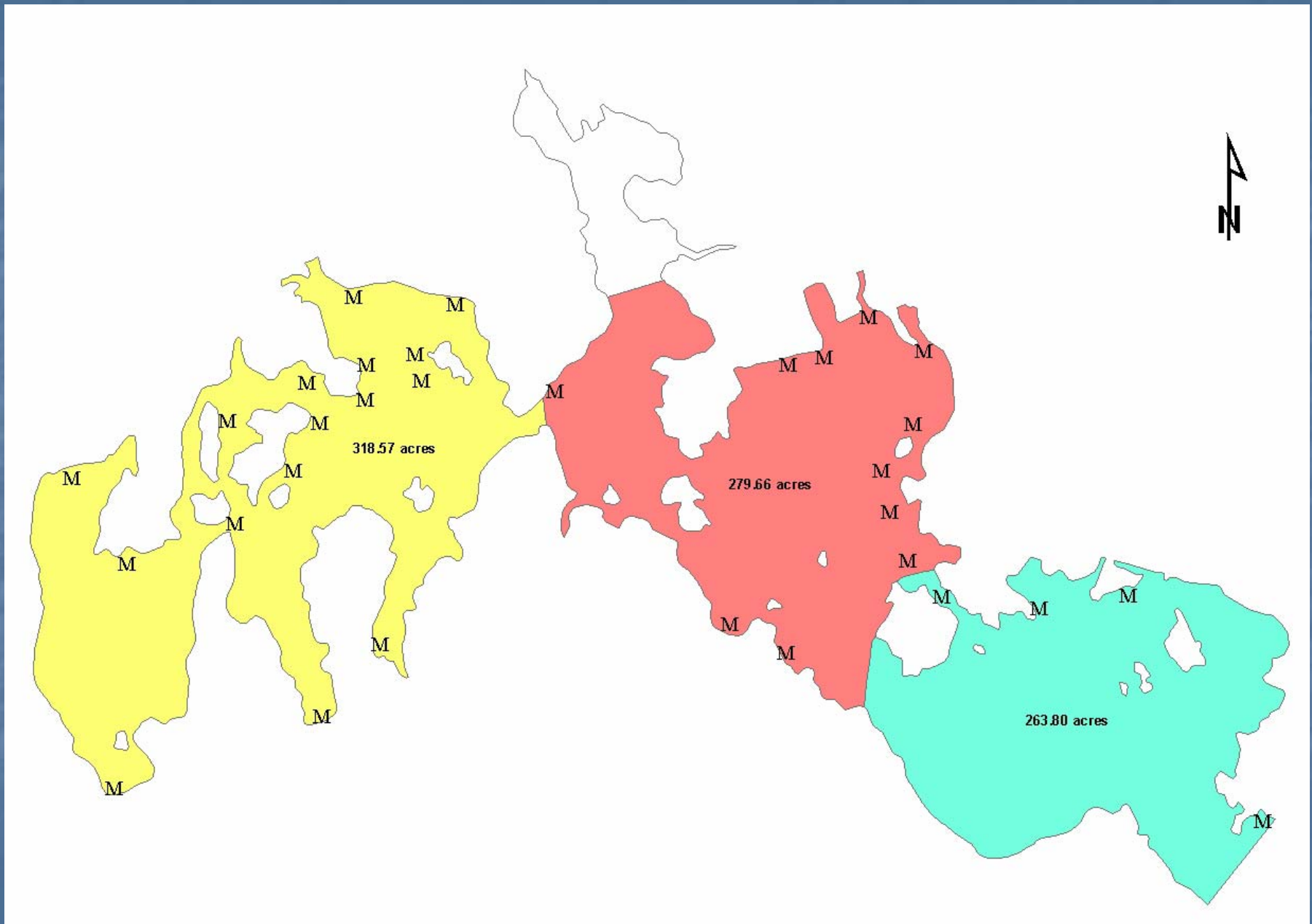
# USGS Research

## *Integration of Hydroacoustical and Water Quality Assessments for Identifying susceptible Areas for Variable Milfoil Establishment in a NH Lake*

Can milfoil distribution be related to various habitat conditions, including geophysical and water quality conditions?

Can a GIS coverage be developed to identify waterbodies and/or areas of waterbodies susceptible to milfoil growth?



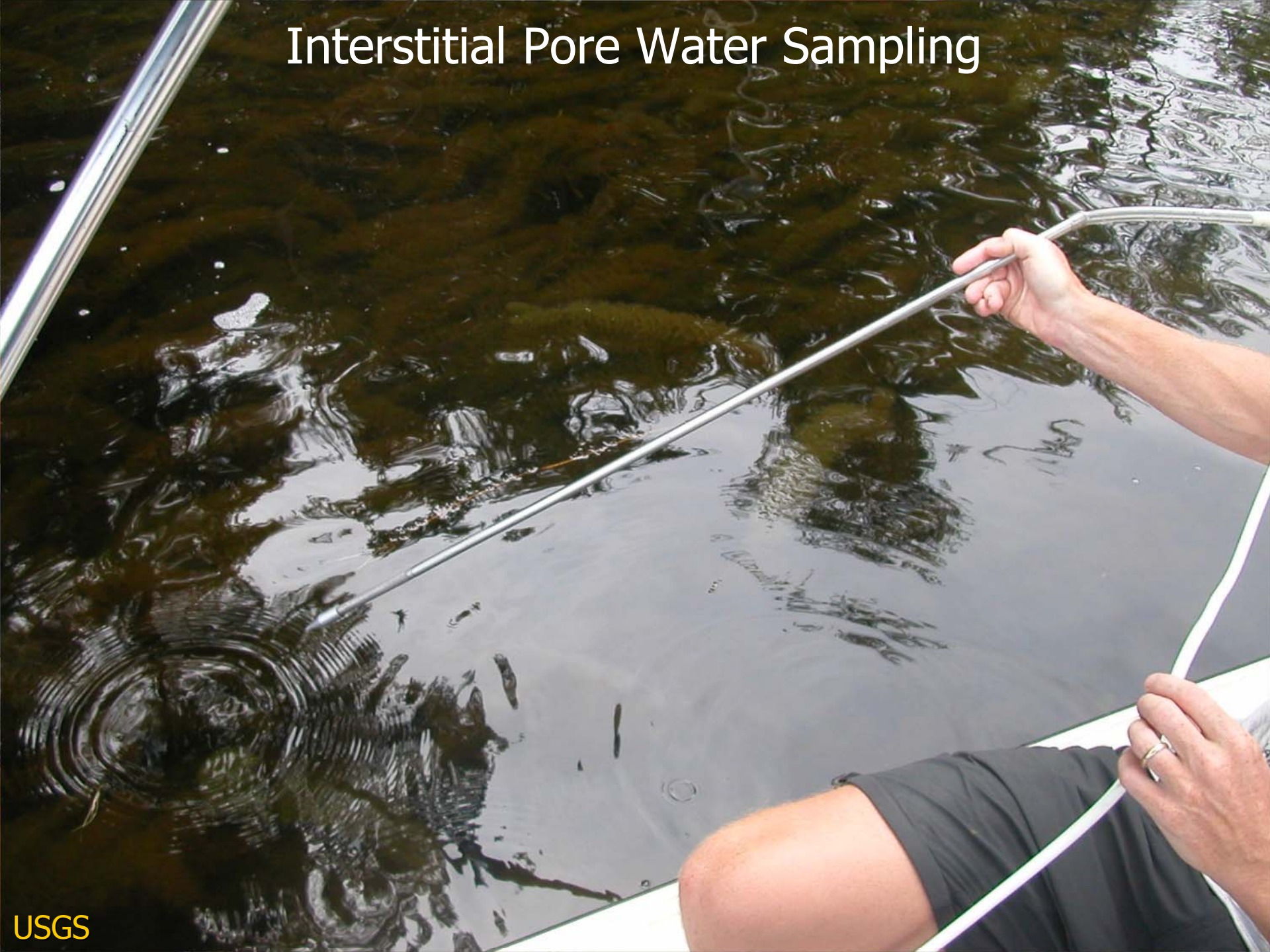




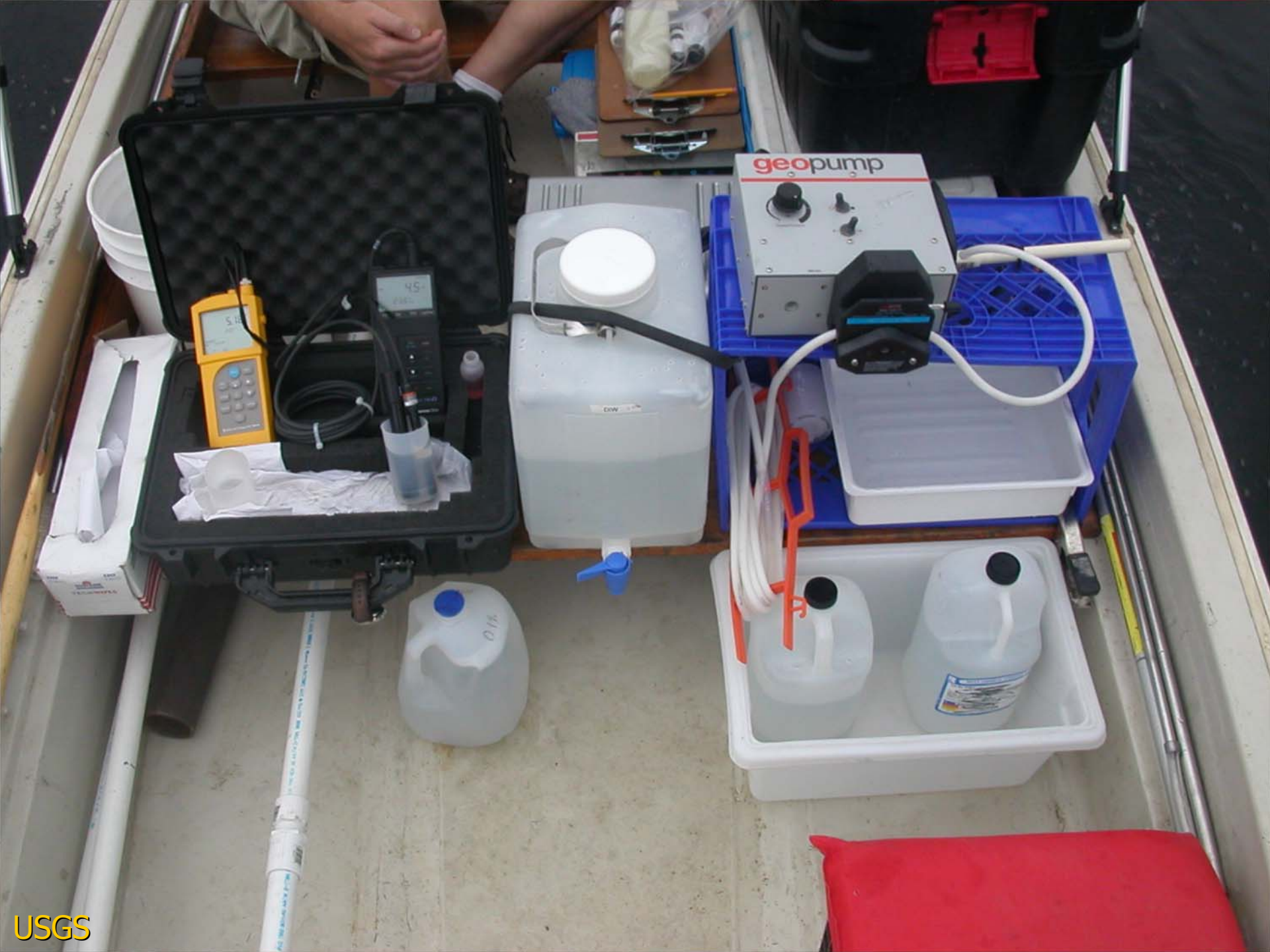




# Interstitial Pore Water Sampling





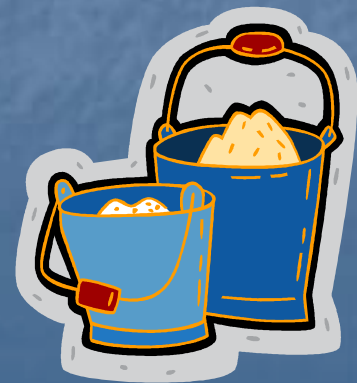




# ENSR Study

## *Relationships Between Variable Milfoil and Sediment, Water Quality and Watershed Features*

Are milfoil infestations, and density of infestations, correlated with lake sediment characteristics, water quality, and watershed characteristics?





Objectives of this study are to:

- Select a series of infested and uninfested waterbodies across NH
- Sample sediments in each of the lakes.
  - In infested lakes, collect samples in areas of low, medium and high density plots of milfoil.
- Evaluate water chemistry from subject waterbodies
- Evaluate watershed features, including wetland complexes and other factors
- Conduct statistical analyses of the data to determine if there are any correlations



# Summer 2005 for ENSR Sediment

- Sampled 25 infested lakes and 15 uninfested lakes for sediment cores
- Gathered existing WQ data for water column chemistry
- Conducted watershed delineations of study lakes and ponds



ENSR- Sediment





ENSR- Sediment





ENSR- Sediment

# Preliminary Results for Sediments

Statistical analyses reveal that the following constituents may influence the overall abundance of milfoil in study waterbodies:

- Percent moisture of sediments
- Total organic carbon
- Total organic content
- Total phosphorus



# Summer 2006

- Continue to evaluate water chemistry
- Continue to evaluate watershed characteristics
- Do statistical analyses
- Prepare final report

# Thum and Lennon Project

*Researching dispersal and environmental variables to predict milfoil occurrence and susceptibility to invasion by variable milfoil in lakes in New Hampshire.*

Are milfoil infestations more a function of environmental conditions or spatial distribution (or a combination of the two)?





- Data acquisition
  - Obtain data sets from DES for multiple parameters of infested and uninfested lakes and ponds
- Data analysis
  - Use statistical analyses to determine relationships among milfoil occurrences and environmental characteristics
    - Canonical correspondence analysis
    - Multivariate analysis of variance
    - Discriminate function analysis
    - Multiple logistic regression



# 2005- Thum/Lennon

- Database creation for 815 waterbodies
- Statistical evaluation
- Multivariate analyses on local controls that could affect whether variable milfoil occurs in a subject waterbody:
  - Water chemistry
  - Lake morphometry
  - Macrophyte diversity



# Questions

- Using a discriminant function analysis, can lakes with variable milfoil be differentiated from lakes without variable milfoil based on environmental characteristics?
  - No
- Using multiple regression analysis, can VM presence be predicted by environmental characteristics?
  - No

# Sources of Error

- There were variables that were not included in the Thum/Lennon analyses, including sediment characteristics and herbivores.
  - Most plants take nutrients out of the sediments, rather than the water column, so there could be a lack of data in the models for this.



# Thum/Lennon Next Steps

## Regional Analysis

- VM is primarily present in the Merrimack River Watershed.
  - Why?
  - Does dispersal of milfoil occur more within a watershed than between a watershed?
- Fine tune models and base them on individual subwatersheds within the Merrimack River Watershed.

# Tools for Management



# Waterways Experimental Stn Project

## *Evaluation of Seven Aquatic Herbicides for the Selective Control of Variable Milfoil*

Which aquatic herbicides most effectively control variable milfoil  
for longer timeframes?

What factors influence the effectiveness of aquatic herbicides we  
use in New Hampshire waterbodies? Is it water quality, plant  
phenology, treatment timing, temperature, or other?





Army Corps



# Progress to Date

- DES sent a few thousand stems of variable milfoil to Gainesville, FL for culturing in aquaria for research
- ACOE planted and grew the plants
- ACOE exposed the plants to various treatments







# Individual Herbicide Trials

- Slow acting enzyme inhibitors-*pending*
  - Fluridone
  - Imazamox
  - Penoxalum
- Fast acting enzyme inhibitors
  - Carfentrazone-*promising*
  - Flumioxazin-*promising*



# Fluridone

(0, 10, 20, 30 ppb)



# Penoxsulam (0, 5, 10, 25 ppb)





# Endothall (0, 1, 2, and 4 ppm)





# Imazamox (0, 10, 25, 50 ppb)



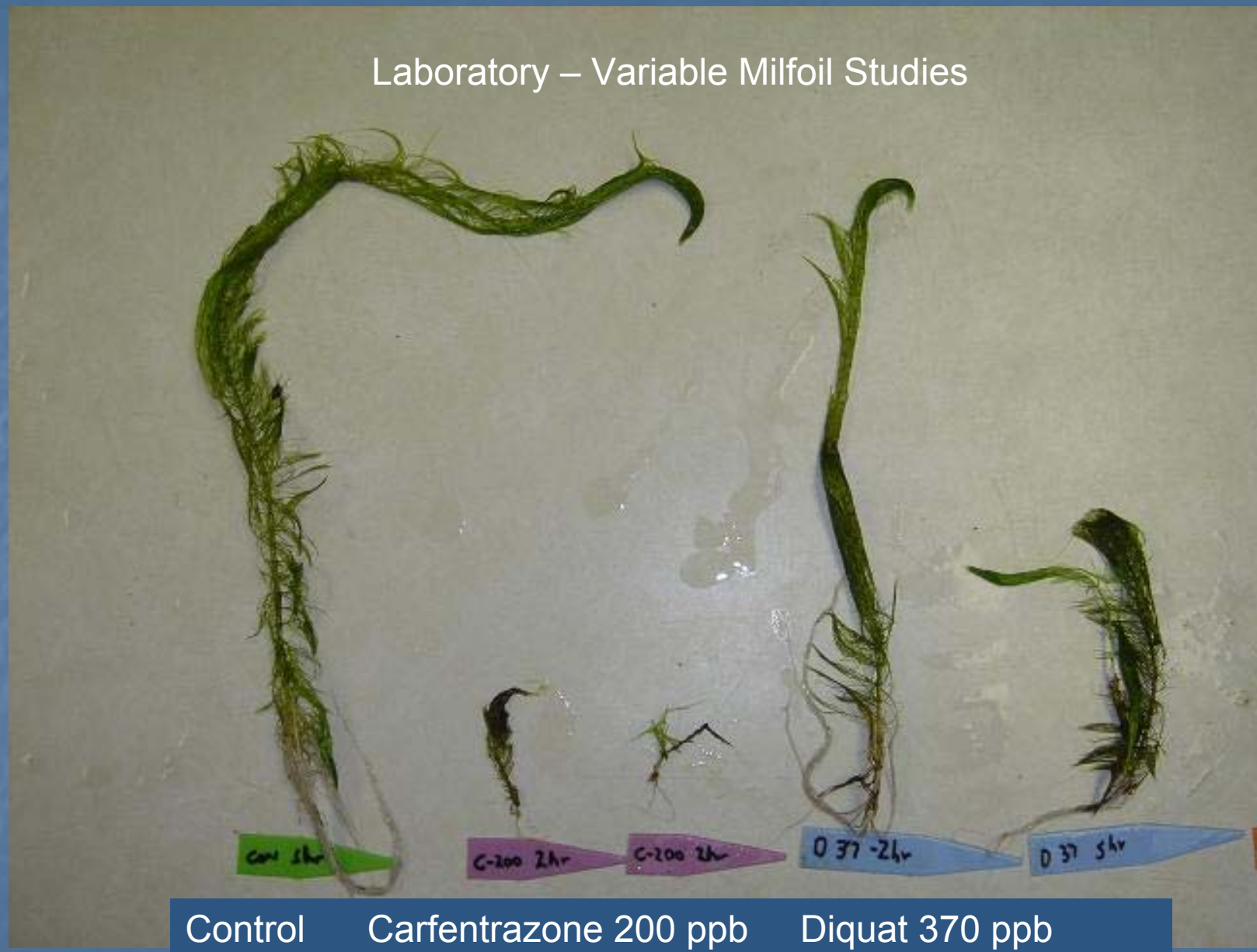
# Diquat

(0, 100, and 200 ppb)





## Laboratory – Variable Milfoil Studies



Control

Carfentrazone 200 ppb

Diquat 370 ppb



# Herbicide and Environmental Condition Comparison

- Herbicide vs. Temperature - *results pending*
  - 2,4-D
  - Carfentrazone
  - Triclopyr
  - Experimental herbicide

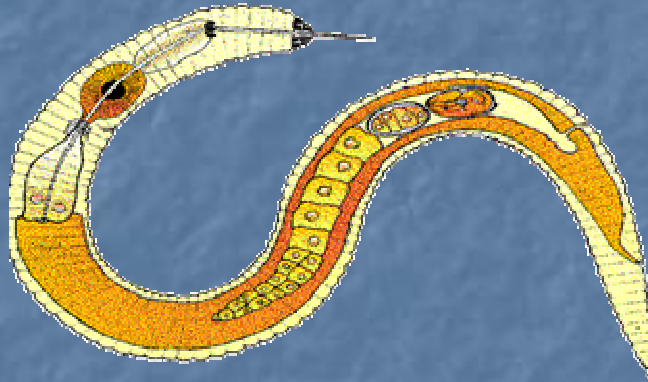
# Liquid vs Granular Herbicide Formulations

- Triclopyr
- 2,4-D

# UNH Freshwater Biology Group

## *An Exploration of the Use of Parasitic Nematodes for the Biological Control of Variable Milfoil*

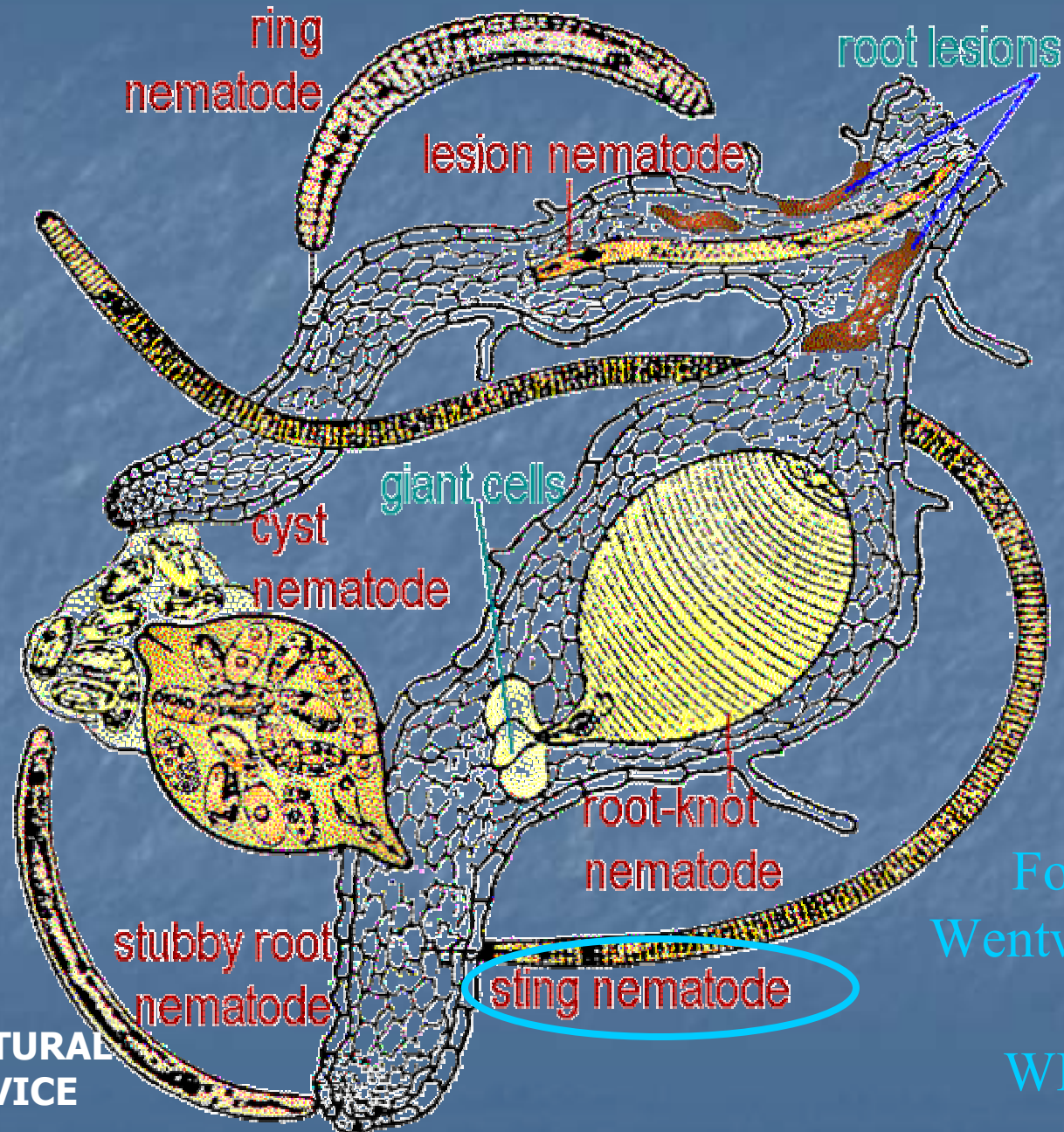
- What are the differences between conditions in NH lakes where milfoil is introduced, and where milfoil is native?



- Are there any possible plant-nematode associations that can be of use in the biological control of variable milfoil?



Nematodes can parasitize plants in different ways:



Found at  
Wentworth Lake  
and  
WI lakes

# Project Overview:

- a) Analyze the physical, chemical and biological characteristics of the water and sediment at native or naturalized sites (found in the Mid-West) and introduced sites (NH). Particular emphasis will be placed on nutrients, anion/cations, pH, alkalinity, in the pore water and bound nutrients and organic matter in sediments, also examine coexisting plant species diversity and extent.
- b) To identify plant feeding and parasitic nematode species within the stem and rhizome of milfoil and associated plants in the different lake sediment environments. Particular emphasis will be placed on the identification of nematode species that have the potential to be biological control agents.

# Summer 2005

- Sediment and plant collection from New Hampshire Lakes
  - Squam Lake/River
  - Lake Wentworth
- Sediment and plant collection from native range of milfoil populations
  - Wisconsin





Eyualet on Round Pond (WI) with sediment core sampler



Scott, Eyualet and Jeff on Wentworth

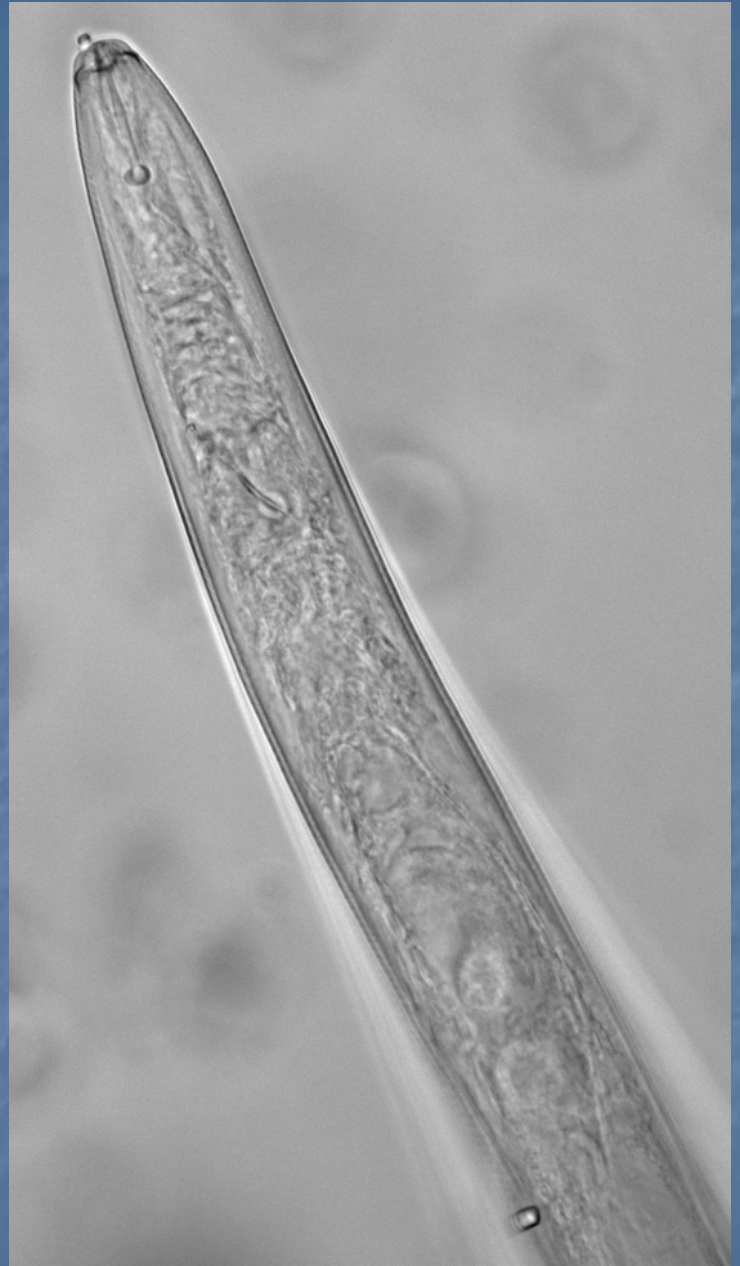


Garrett on Rock Dam Lake (WI) with Milfoil

# Observations to Date

- *M. heterophyllum* is not as prevalent as expected in WI (mis-IDed or just scarce).
- WI communities are found in shallower waters along with floating and emergent plants even though water clarity is similar to NH.
- WI communities may become more aggressive when impacted by boat traffic (fragmentation)
- WI sediments had higher densities and diversity in sediment and plant nematodes than NH so far.
- Older, more established stands of milfoil in NH lakes had more density and diversity of Nematodes
- Potentially parasitic nematode similar in form to a known aquatic plant parasite was found at Lake Wentworth





*Hirschmanniella*-like Nematode found at Lake Wentworth





*Hirschmanniella* has been documented as a rice plant parasite. Thus, we have keen interest in this similar looking species found at Lake Wentworth in NH.



# 2006 Work in Progress

- Sample additional NH lakes and MI lakes for sediment conditions and nematodes associated with our target milfoil.
- Re-sample Wentworth
- Sample nematode community associated with native NH milfoils.
- Finish DNA typing of all nematodes found
- Compare pore water and sediment chemistry results with nematodes found.

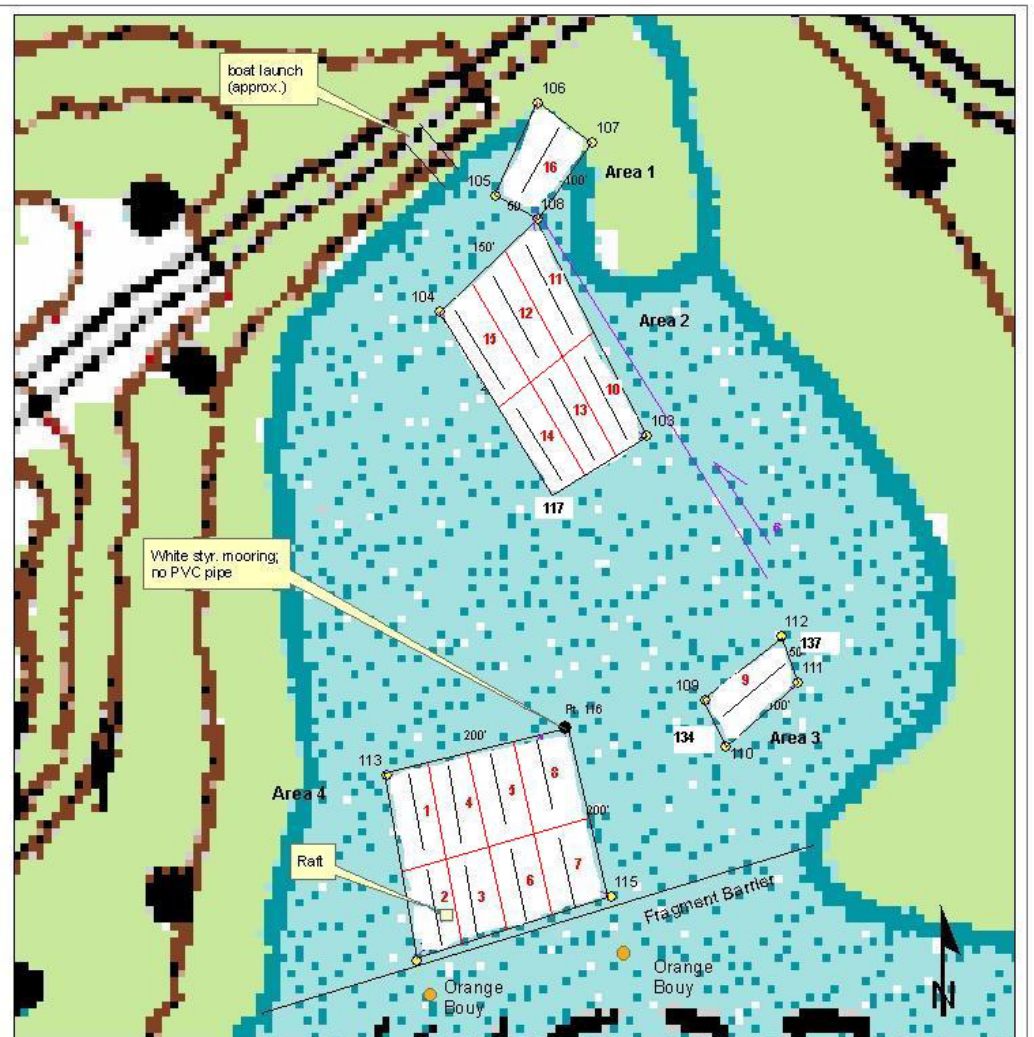


# ENSR

## *Plant Replacement Project*

Can we successfully remove  
milfoil infestations and  
revegetate with native species  
to inhibit milfoil regrowth?





Outline of areas to be suction harvested (1-4)



Transect lines for videotaping



Dividing line for treatment plots

103

GPS point number (see additional maps for transect point numbers)

16

Plot or transect number

Note:

1. Adapted from USGS Bradford, NH and Hillsboro Upper Village, NH 7 1/2 minute maps.
2. Distances are accurate but absolute position of beds is approximate.

Lake Massasecum  
Milfoil Project  
for the  
NHDES  
August 2005



# Summer of 2005

- Suction harvesting of 2 acres of milfoil from northern end of Lake Massasecum
  - 2 weeks of dive time
  - 182 hours total time
- Transplanting of native vegetation from various parts of lake to newly harvested area
  - 228 total hours
- End of season follow-up





ENSR Plant Replacement





ENSR Plant Replacement



# Conclusions from Summer 2005

- Suction harvesting reduced milfoil abundance by 87%
- Suction harvesting reduced native species by 42%
- Planting only increased native plant density by 3-10% in north end of lake
- 2006 will be spent monitoring plant growth patterns for planted natives and residual milfoil





2006

# What's the Big Picture?





# Summary- Risk Assessment

- There appear to be some characteristics of lake sediments that are linked with milfoil growth
- There appears to be some distribution of milfoil in relation to spatial characteristics in New Hampshire, with regards to watersheds



# Summary- Control

- Some new aquatic herbicides are showing promise for effective control of milfoil, including biomass reduction
- Herbicide efficacy can possibly be linked to environmental characteristics in the waterbody
- Nematode assemblages in some waterbodies may provide some possible new avenues for milfoil control
- Suction harvesting is a useful tool in removing small infestations of exotic plants
- Plant replacement success....wait and see.

# The future...and beyond

- Some laboratory trials will need to be taken to the field to be tested
- Possibility of more funding needs in the future
  - NH state funded research grants (~60K available annually)
- Deliverables
  - Peer reviewed journal articles
  - Recommendations to state agency from researchers
  - 'Milfoil Summit' or other press release forum to share information

# Want more information?

- Visit the Exotic Species website for frequent updates at [www.des.state.nh.us/wmb/exoticspecies/](http://www.des.state.nh.us/wmb/exoticspecies/)
- Check out the Exotic Species Program Reports
  - 1999-2001, 2002-2003, and 2004-2005 reports are available online
- Contact Amy Smagula at 603-271-2248 or [asmagula@des.state.nh.us](mailto:asmagula@des.state.nh.us)

